GEO Group Northwest, Inc.
Geotechnical Engineers, Geologists
& Environmental Specialists

October 13th 2022 G-5776

Mr. Robert Chang
Email: robertchanf@gmail.com

Subject: **Geotechnical Engineering Investigation**
Proposed New Deck and Stairs
9405 SE 47th St
Mercer Island, Washington

Dear Mr. Chang:

At your request, GEO Group Northwest, Inc., conducted a geotechnical engineering investigation at the above-subject location for a proposed new deck and stairs on your property in Mercer Island, Washington. We understand the city of Mercer Island has requested a geotechnical report to assess the seismic, erosion and landslide hazards onsite and respond accordingly with recommendations to mitigate onsite hazards. The scope of our services included a review of the geologic maps of the area and providing a characterization of the subsurface soil and groundwater conditions encountered, preparation of boring logs (attached) and preparation of this geotechnical report.

SITE CONDITIONS

Site Description

The project site is located in East Mercer Island, Washington, as illustrated in *Plate 1 – Site Location Map*. The parcel is rhombus-shape and slopes from the north-west to the south-east corners of the property at the lowest elevation. The parcel consists of 13102 square feet and is bounded by other single family residential properties to the east, west, SE 47th St to the north, and SE 47th St open green space to the south.

The existing single-family residence was built in 1977 and has two stories and an attached garage with approximately 2820 square feet of total living space. A second story deck with stairs is attached to the south side of the existing house and a 4-foot-high concrete block retaining wall that runs approximately 10 feet to the south of the existing deck at the base of the yard.
The project site is mapped by the City of Mercer Island as having a protected slope, landslide hazard, erosion hazard and groundwater.

Description of Proposed Development

The proposed deck and stairs will replace the existing deck and stairs with no changes to the current footprint. The wooden deck will be approximately 483 square feet and the stairs will be approximately 45 square feet connecting the left and right sides of the deck. The retaining wall, house and yard will not be altered save for a landing and entry way on the west side of the existing deck that will be removed entirely. Please see *Plate 2 – Site Plan*

SITE INVESTIGATION

Geologic Overview

Based on a review of the geologic map for the area, the surficial soil in the area is mapped as Lawton Clay (Qvlc). Lawton clay is typically laminated to massive silt, clayey silt, and silty clay with scattered dropstones deposited in lowland proglacial lakes. This deposit marks the transition from nonglacial to the earliest glacial time. Locally can have fine grain sediments deposited from the cascade mountains. Typically, Lawton clay is very stiff to hard, with vertical fractures and fine sand partings. The project site is mapped by the City of Mercer Island as being in a protected slope area, being a potential landslide area, having an erosion hazard and groundwater.

Subsurface Investigation

On September 22nd a Staff Engineering Geologist from our firm, visited the site to perform a visual reconnaissance of the site and investigate the subsurface soil conditions and geologic hazard areas. Erosion was observed around some of the existing deck footings, and in the south-west corner of the property some loose material was deposited south of the garage west of the stairway and landing that are to be removed. A 4-foot-high retaining wall was observed to run through the center of the property approximately 10 feet south from the existing deck. The wall varies slightly in height from east to west with the south-east corner taller than the rest of the

wall. The wall was observed to have crushed rock backfill and no signs of instability were observed.

Hand Auger 1 (HA-1) was dug to the south-east side of the existing deck, dense, dry silty sand with gravel and silt were observed 1 foot to 1.5 feet below the ground surface. The area below the existing deck, by the footings and under the west side of the existing deck was probed and found to be dense. In our opinion, dense native soils will be encountered at similar depths approximately 1-2 feet below ground surface. We interpret these dense soils to be dense, native Lawton Clay. No groundwater was observed onsite. For a more detailed description of the soils encountered, please refer to the boring logs in *Appendix A.*

CRITICAL AREAS

The Project site is mapped to overly a City of Mercer Island Seismic, Potential Slide and Erosion Hazard area. As part of our scope of work we evaluate the hazard with respect to the project scope of work. Please see *Plate 3 and 4 – Hazardous Areas Map.*

Seismic and Potential Landslide Hazard

According to the City of Mercer Island, a seismic hazard area is an area that has potential for seismically induced ground failures including settlement, cracking, lateral spreading and liquefaction due to ground shaking. The site is also mapped as a potential slide area, as having a scarp upslope to the west of the site, and as having a landslide deposit beneath the site and several surrounding properties. Landslide deposits are typically loose to medium dense and massively bedded, however onsite we observed dense native soils in the location of the proposed addition. In our professional opinion, because of the dense native soils observed onsite, the risk of a potential slide or seismically induced settlement or failure is low.

Erosion Hazard

The site is also mapped as an erosion hazard area, and onsite we observed signs of erosion around the existing footings. We also observed erosion and deposited soft soils on the south-west corner of the house to the side of the existing deck. Water from the deck should be re-routed away from the footings and to the other side of the retaining wall. Please see the recommendations outlined below for details.

CONCLUSIONS AND RECOMMENDATIONS

The site is underlain with hard, Silty and sandy soils that we interpret to be dense native soils, no groundwater was observed. We recommend the proposed addition be supported on conventional concrete footing foundations that bear on dense native soils or on structural fill that is placed on a subgrade of dense native soil. Based on the findings from our investigation, bearing soils are anticipated at depth of approximately 2 feet below the existing ground surface. Because some erosion was observed onsite, we recommend a layer of crushed rock be placed below the deck. We also recommend a 1-foot-deep, crushed rock trench lining the south most perimeter of the deck, tying into the footing drain on the south-east corner of the house. Detailed recommendations regarding geotechnical aspects of the project are presented in the following sections of this report. From our subsurface investigation, we observed that the soils are dense and no signs of creep or instability were observed onsite. In our opinion, as long as our recommendations for proper drainage are applied the risk of a potential slide, seismic induced settling and erosion in the project area is low because of the dense to very dense soils.

Seismic Site Design Classification and Design Parameters

Based on guidance provided in the 2018 edition of the International Building Code (IBC), it is our opinion that the project site meets the criteria for seismic Site Class D for Stiff Soils. Seismic design parameters applicable for the site, based on the assigned Site Class D and design calculations per the 2018 IBC, are as follows:

S_s = 1.429 g	S_{ms} = 1.429	S_{ds} = 0.952
S_1 = 0.496g	S_{m1} = null	S_{d1} = null

The peak ground acceleration for the site, adjusted for the assigned site class, is 0.612g based on USGS seismic hazard design mapping per the 2018 IBC

Foundations

Soils that are anticipated to be acceptable for building support were encountered at a depth of approximately 1-2 feet bgs in the hand auger boring that was completed for our investigation. Based on these findings, it is our opinion that new foundations for the project can consist of conventional concrete strip and column footings that bear directly on dense native soils or on compacted, crushed rock structural fill that has been placed on a subgrade of dense or very dense

native soils. Our recommended design criteria for conventional footing foundations supported on native soils or crushed rock structural fill are provided below.

- Allowable bearing pressure, including all dead and live loads:
  - Undisturbed, dense or very dense soil = 2,000 psf
  - Structural fill placed on dense or very dense soil = 2,000 psf

- Minimum depth to base of perimeter footing below adjacent exterior grade = 18 inches
- Minimum depth to bottom of interior footings below top of floor slab = 12 inches
- Minimum width of wall footings = 16 inches

- Minimum lateral dimension of column footings = 24 inches
- Estimated post-construction settlement = ½ inch
- Estimated post-construction differential settlement across building width = ½ inch

A one-third increase in the above allowable bearing pressures can be used when considering short-term transitory wind or seismic loads. Lateral loads against the building foundations can be resisted by friction between the foundation and the supporting subgrade or by passive earth pressure acting on the buried portions of the foundations. For the latter case, the foundations must be poured "neat" against the existing undisturbed soil or be backfilled with compacted structural fill. Our recommended parameters are as follows:

- Passive Pressure (Lateral Resistance)
  350 pcf, equivalent fluid weight, for structural fill or competent undisturbed native soil

- Coefficient of Friction (Friction Factor)
  0.35 for structural fill or competent undisturbed native soil.

Grading and Earthwork

Some erosion was observed onsite beneath the deck and around the footings. To mitigate future erosion, we recommend a 4-inch layer of clean crushed rock overlying non-woven geotextile filter fabric (Miraf 140 NL or equivalent), be placed below the deck to route water to a perimeter trench. An approximately 1-foot-deep trench consisting of filter fabric and crushed rock should be placed around the perimeter of the deck to catch stormwater. A perforated or slotted rigid PVC pipe should be tight jointed and laid with perforations or slots down. Do not replace rigid

PVC pipe with flexible corrugated plastic pipe. Please see *Plate 4 – Drainage Trench for Runoff.* This water should then be routed to the footing drain on the south-east corner of the house and piped into the recharge area beyond the retaining wall.

Drainage

Water should not be allowed to stand in areas where footings, slabs, or pavements are to be constructed. Final site grades should provide drainage away from the deck structure.

Mercer Island Unified Land Development Code Geologically Hazardous Areas per Requirement 19.07.160.B

An evaluation of site-specific subsurface conditions demonstrates that the proposed development is not located in a landslide hazard area or seismic hazard area and the development is so minor as not to pose a threat to the public health, safety and welfare.

LIMITATIONS

The findings and recommendations stated herein are based on field observations, our experience on similar projects and our professional judgment. The recommendations presented herein are our professional opinions derived in a manner consistent with the level of care and skill ordinarily exercised by other members of the profession currently practicing under similar conditions in this area and within the project schedule and budget constraints. No warranty is expressed or implied. In the event that site conditions are found to differ from those described in this report, we should be notified so that the relevant recommendations in this report can be reevaluated and modified if appropriate.

CLOSING

We appreciate the opportunity to provide you with geotechnical engineering services for this project. Please do not hesitate to contact us if you have any questions regarding this report.

Sincerely,

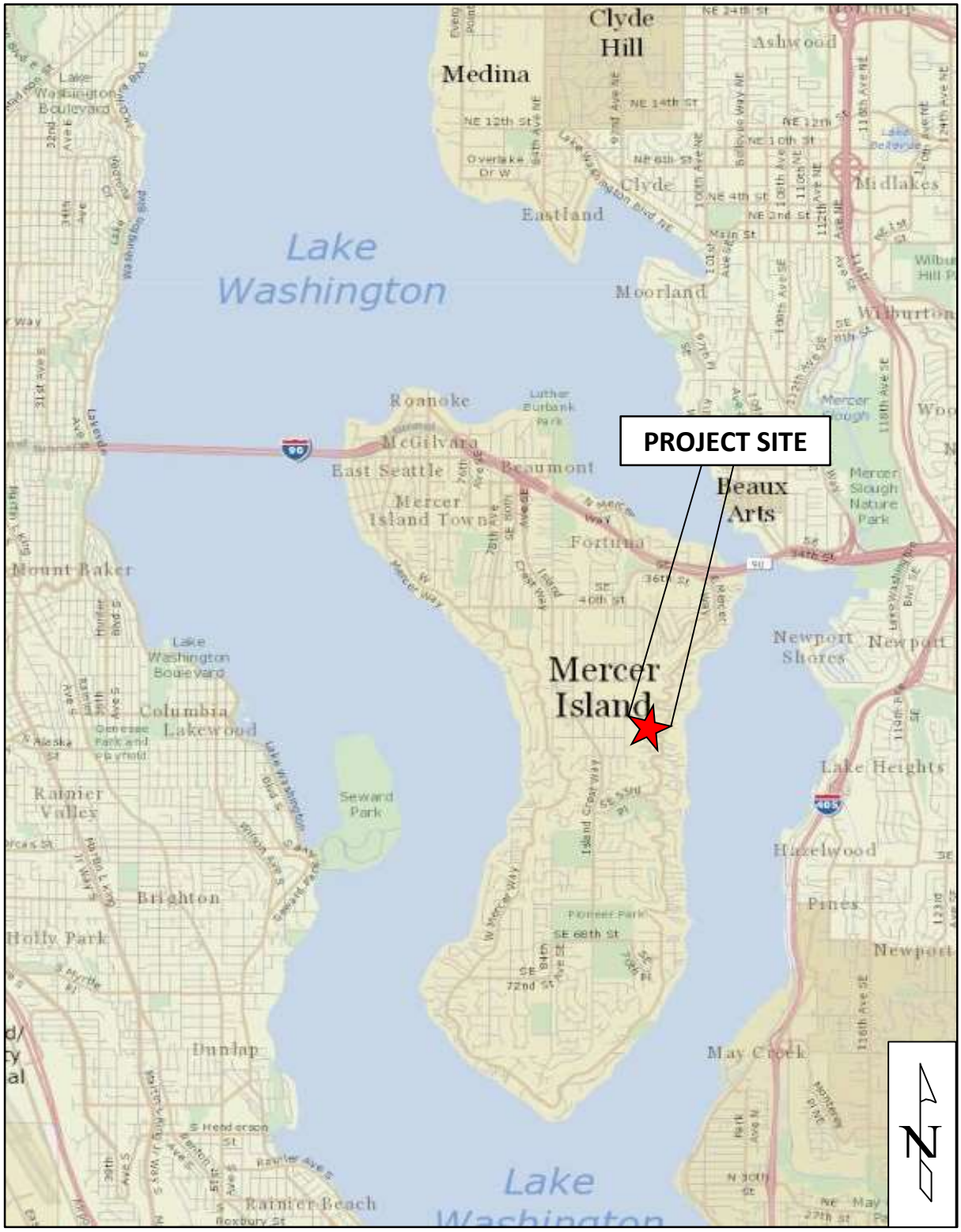
GEO Group Northwest, Inc.

Sophie Holt, G.I.T.
Staff Engineering Geologist

William Chang, P.E.
Principal Engineer

Attachments:

Plate 1 – Site Location Map
Plate 2 – Site Plan
Plate 3 – Critical Areas
Plate 4 – Critical Areas
Plate 5 – Typical Footing Drain
Appendix A – USCS Soil Classification Legend & Soil Boring Logs



Source: King County iMap, 2021

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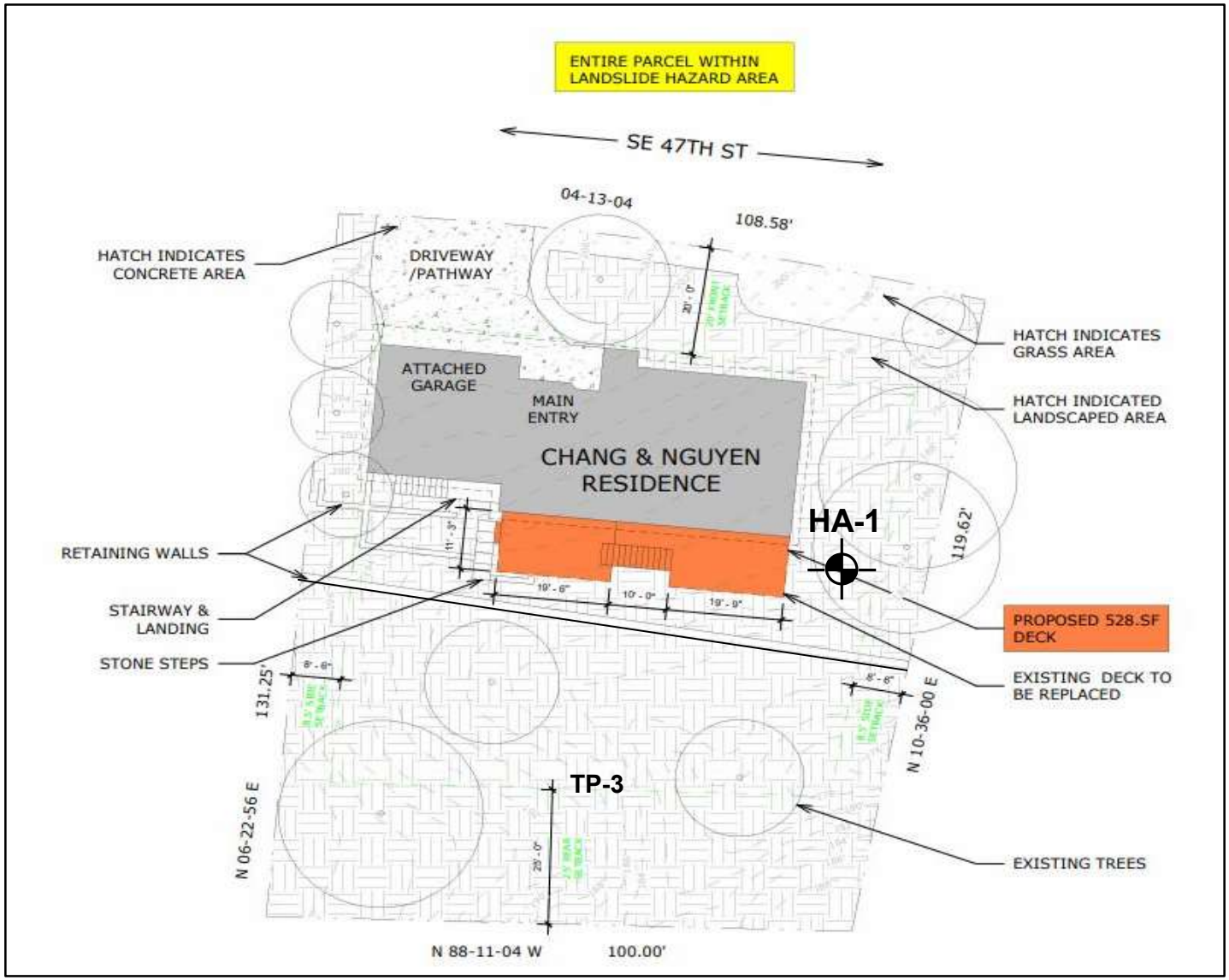
SITE LOCATION MAP

PROPOSED NEW DECK AND STAIRS
9405 SE 47TH ST
MERCER ISLAND, WASHINGTON

SCALE	DATE	MADE	CHKD	JOB NO.	PLATE
NONE	10/13/2022	SH	WC	G-5776	1



LEGEND

HAND AUGER LOCATION

PROPOSED

SCALE:	NO SCALE	**DRAWN:**	SH	**CHECKED:**	WC	**DATE:**	10/13/2022	**PROJECT NO.:**	G-5776	**PLATE**	2

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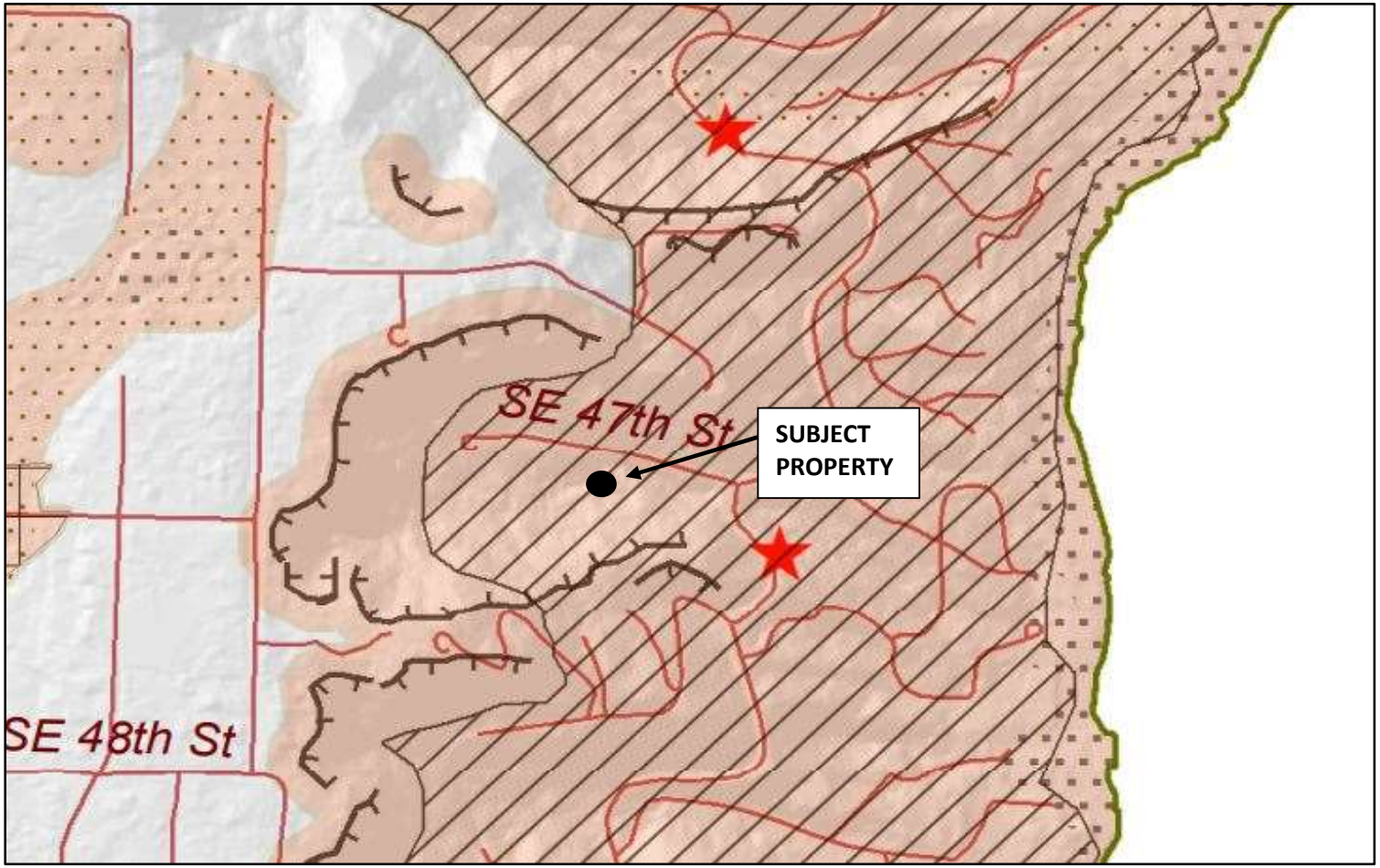
SITE PLAN

PROPOSED NEW DECK AND STAIRS
9405 SE 47TH ST
MERCER ISLAND, WASHINGTON



N

LEGEND

POTENTIAL SLIDE

PAST GROUND MOVEMENT

SCARP

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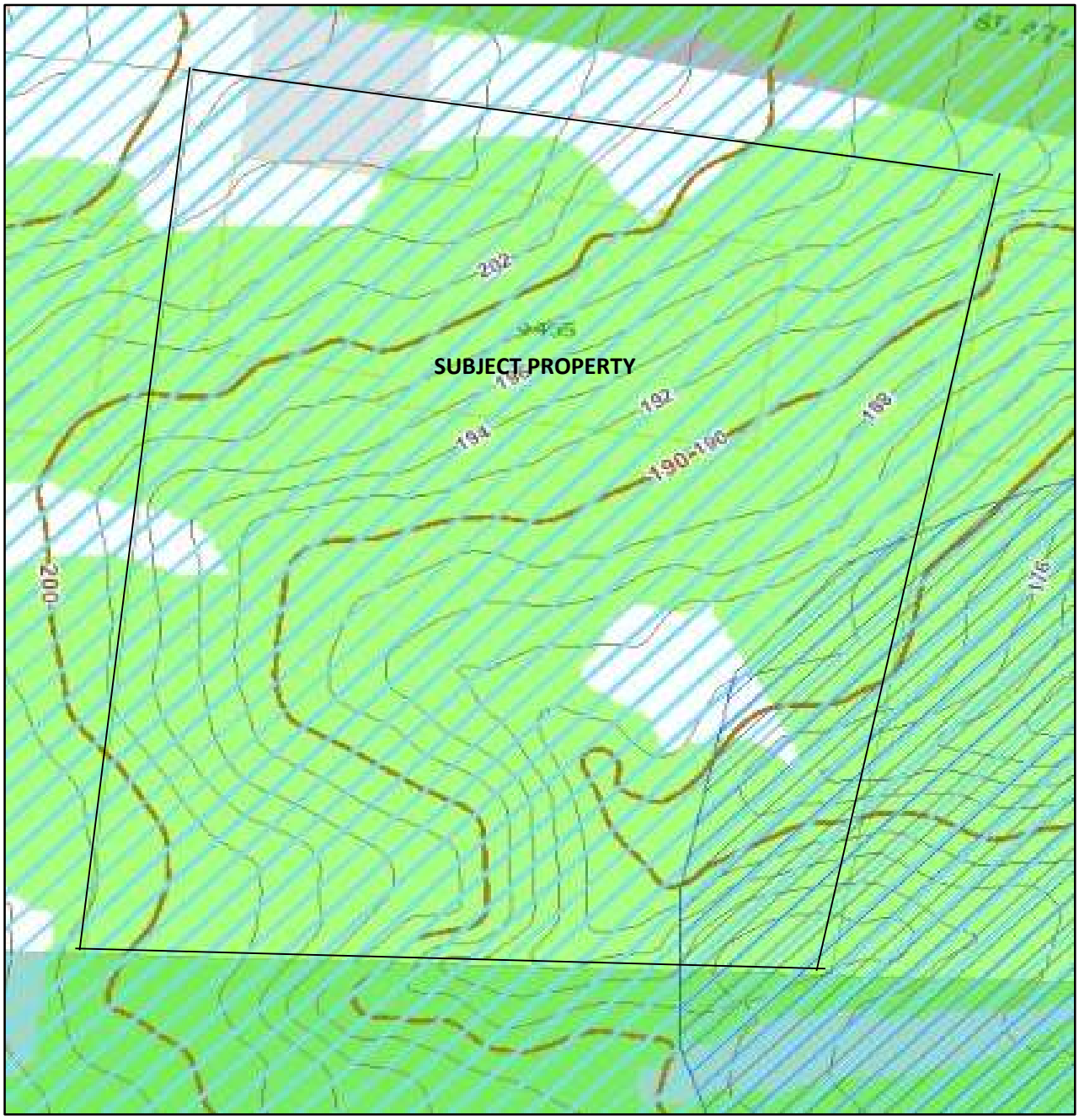
LANDSLIDE DEPOSITS

PROPOSED NEW DECK AND STAIRS

9405 SE 47TH ST

MERCER ISLAND, WASHINGTON

SCALE:	NO SCALE	DRAWN:	SH	CHECKED:	WC	DATE:	10/13/2022	PROJECT NO.:	G-5776	PLATE	3



LEGEND

POTENTIAL SLIDE

GROUND WATER

PROTECTED SLOPE

Source: City of Mercer Island GIS

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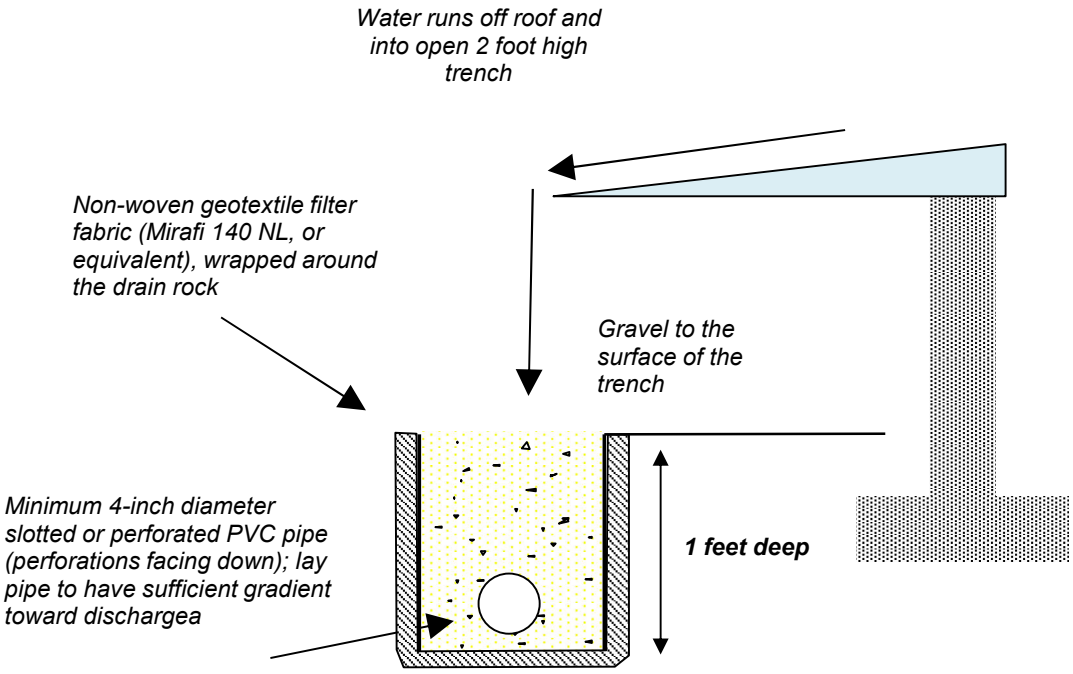
SITE LOCATION MAP

PROPOSED NEW DECK AND STAIRS
9405 SE 47TH ST
MERCER ISLAND, WASHINGTON

SCALE	DATE	MADE	CHKD	JOB NO.	PLATE
NONE	10/13/2022	SH	WC	G-5776	4

TYPICAL RUNOFF TRENCH



NOT TO SCALE

NOTES:

1.) Runoff trench is to be placed around the perimeter of the structure to route water to pipes leading to the footing drain. A four-inch slotted pipe should be at the base of the trench. Perforated or slotted rigid PVC pipe should be tight jointed and laid with perforations or slots down. Do not replace rigid PVC pipe with flexible corrugated plastic pipe.

2.) Trenche should be 1 foot deep

3.) The geotextile filter fabric should be placed around the drain rock as shown, and not wrapped directly around the pipe. The surface of the trench should be open, and then be filled with gravel to the surface.

4.) Water from the perimeter trench shouldbe routed to a pipe to south-east footing drain

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TYPICAL ROOF RUNOFF TRENCH
PROPOSED NEW ROOF
9405 SE 47TH ST
MERCER ISLAND, WASHINGTON

SCALE: NONE	**DATE:** 10/13/2022	**MADE:** SH	**CHKD:** WC	**JOB NO.** G-5776	**PLATE** 5

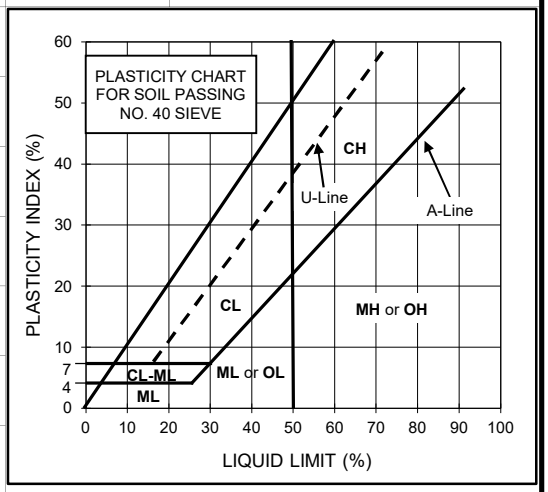
APPENDIX A

USCS Soil Classification Legend & Soil Boring Logs

SOIL CLASSIFICATION & PENETRATION TEST DATA EXPLANATION

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS	GRAVELS (More Than Half Coarse Fraction is Larger Than No. 4 Sieve)	CLEAN GRAVELS (little or no fines)	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURE, LITTLE OR NO FINES	CONTENT OF FINES BELOW 5%	Cu = (D60 / D10) greater than 4 Cc = $(D30)^2$ / (D10 * D60) between 1 and 3
			GP	POORLY GRADED GRAVELS, AND GRAVEL-SAND MIXTURES LITTLE OR NO FINES		CLEAN GRAVELS NOT MEETING ABOVE REQUIREMENTS
		DIRTY GRAVELS (with some fines)	GM	SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	GM: ATTERBERG LIMITS BELOW "A" LINE. or P.I. LESS THAN 4
			GC	CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		GC: ATTERBERG LIMITS ABOVE "A" LINE. or P.I. MORE THAN 7
More Than Half by Weight Larger Than No. 200 Sieve	SANDS (More Than Half Coarse Fraction is Smaller Than No. 4 Sieve)	CLEAN SANDS (little or no fines)	SW	WELL GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	CONTENT OF FINES BELOW 5%	Cu = (D60 / D10) greater than 6 Cc = $(D30)^2$ / (D10 * D60) between 1 and 3
			SP	POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES		CLEAN SANDS NOT MEETING ABOVE REQUIREMENTS
		DIRTY SANDS (with some fines)	SM	SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE with P.I. LESS THAN 4
			SC	CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE with P.I. MORE THAN 7
FINE-GRAINED SOILS	SILTS (Below A-Line on Plasticity Chart, Negligible Organics)	Liquid Limit < 50%	ML	INORGANIC SILTS, ROCK FLOUR, SANDY SILTS OF SLIGHT PLASTICITY		
		Liquid Limit > 50%	MH	INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOIL		
	CLAYS (Above A-Line on Plasticity Chart, Negligible Organics)	Liquid Limit < 50%	CL	INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY CLAYS, LEAN CLAYS		
		Liquid Limit > 50%	CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
Less Than Half by Weight Larger Than No. 200 Sieve (i.e., fines)	ORGANIC SILTS & CLAYS (Below A-Line on Plasticity Chart)	Liquid Limit < 50%	OL	ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY		
		Liquid Limit > 50%	OH	ORGANIC CLAYS OF HIGH PLASTICITY		
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS		



SOIL PARTICLE SIZE

FRACTION	U.S. STANDARD SIEVE			
	Passing		Retained	
	Sieve	Size (mm)	Sieve	Size (mm)
SILT / CLAY	#200	0.075		
SAND				
FINE	#40	0.425	#200	0.075
MEDIUM	#10	2.00	#40	0.425
COARSE	#4	4.75	#10	2.00
GRAVEL				
FINE	0.75"	19	#4	4.75
COARSE	3"	76	0.75"	19
COBBLES	76 mm to 203 mm			
BOULDERS	> 203 mm			
ROCK FRAGMENTS	> 76 mm			
ROCK	>0.76 cubic meter in volume			

GENERAL GUIDANCE FOR ENGINEERING PROPERTIES OF SOILS, BASED ON STANDARD PENETRATION TEST (SPT) DATA

SANDY SOILS				SILTY & CLAYEY SOILS		
Blow Counts N	Relative Density, %	Friction Angle ϕ, degrees	Description	Blow Counts N	Unconfined Strength q_u, tsf	Description
0 - 4	0 -15		Very Loose	< 2	< 0.25	Very soft
4 - 10	15 - 35	26 - 30	Loose	2 - 4	0.25 - 0.50	Soft
10 - 30	35 - 65	28 - 35	Medium Dense	4 - 8	0.50 - 1.00	Medium Stiff
30 - 50	65 - 85	35 - 42	Dense	8 - 15	1.00 - 2.00	Stiff
> 50	85 - 100	38 - 46	Very Dense	15 - 30	2.00 - 4.00	Very Stiff
				> 30	> 4.00	Hard

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PLATE A1

HAND-AUGER BORING: HA-1

LOGGED BY SH LOG DATE: 9/22/2022 GROUND ELEV.

DEPTH ft.	USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS/ COMMENTS
1	SM	2 inch layer of topsoil, roots, below grass			
2		SILTY SAND with gravel, yellow, cobbles and roots, dry, staining and mottling, fines content of approximately 30-40%, dense	S1		-Probe 0.5"' at 1.5'
3		**Total Depth: 1.75 feet bgs** **Groundwater encountered: No**			
4					
5					
6					
7					

HAND-AUGER BORING: HA-2

LOGGED BY SH LOG DATE: 8/20/2022 GROUND ELEV.

DEPTH ft.	USCS	SOIL DESCRIPTION	SAMPLE No.	Water %	OTHER TESTS/ COMMENTS
8	SM				-Probe 0" at 0.5'
9					
10					
11					
12					
13					
14					

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Geotechnical Engineers, Geologists, & Environmental Scientists

HAND AUGER BORING LOGS

PROPOSED NEW DECK
9405 SE 47TH ST
MERCER ISLAND, WASHINGTON

JOB NO.	G-5776	DATE	10/13/22	APPEND.	A2